P. C. 9

A CONTRIBUTION

TO THE

Natural History of Scarlet Fever.

18.

BASED UPON

OFFICIAL STATISTICAL RECORDS OF MORTALITY AND MORBIDITY.

BY

JOHN T. WILSON, M.D., D.P.H. (ABERD.),
Medical Officer of Health, Lanarkshire.

Supplement to **Public Health**, *February, 1897,*

THE OFFICIAL JOURNAL OF THE INCORPORATED SOCIETY OF MEDICAL OFFICERS OF HEALTH.

PUBLISHED AT THE JOINT EXPENSE OF THE SOCIETY AND OF THE AUTHOR.

LONDON:
PRINTED BY W. H. AND L. COLLINGRIDGE, 148 AND 149, ALDERSGATE STREET, E.C.

PRINTED BY
W. H. AND L. COLLINGRIDGE,
148 AND 149, ALDERSGATE STREET,
LONDON, E.C.

INTRODUCTORY.

THIS Paper embraces the greater part of a Thesis for the Degree of Doctor of Medicine, accepted and commended by the University of Aberdeen, in March, 1896. The Appendix, comprising twenty-two tables of Annual Statistics, has been omitted, owing to the cost of reproduction, but its contents are summarised in the tables scattered throughout the text.]

WITH the introduction of compulsory notification of infectious disease by medical practitioners and the establishment of fever hospitals, furnishing statistics of sickness or morbidity, fresh material now exists, and is rapidly accumulating, for the further elucidation of problems connected with the natural history of the diseases notified. Scarlet Fever is one of these diseases, and the need for such material is keenly felt in seeking to account for the great reduction in its mortality during recent years. Towards determining the causes of the reduction in Scarlet Fever mortality the greater part of this thesis is devoted. Deeply conscious of the vastness of the subject, the importance of the questions raised, and the need for exhaustive inquiry, I have brought together a considerable quantity of material, which is arranged in two parts. In Part I. I have endeavoured to ascertain to what extent the reduction has affected the different communities (urban and rural) in Scotland, England, and Ireland, and also whether a similar reduction has been observed in other countries than the United Kingdom. After having discussed these and other questions related to the progress of Scarlet Fever mortality, I have sought to determine in Part II. the causes of diminution in mortality, from statistics of morbidity and fatality.

The sources from which the statistical material has been drawn are mostly well known The statistics of mortality relating to the United Kingdom are taken from the annual and other reports of the Registrars-General for Scotland, England, and Ireland. Those relating to other countries are obtained from sources which are acknowledged where given. The statistics of morbidity and fatality have, to a large extent, been obtained privately from Health Officers and their reports, and also from the reports of the Local Government Boards for Scotland and England.

To all those who have furnished me with statistics I gratefully acknowledge my indebtedness, and hope the care I have bestowed in their preparation has ensured accuracy.

The term *fatality* is used exclusively to denote the relation of deaths to sicknesses, and is statistically expressed as the proportion of deaths in a given number of cases.

JNO. T. WILSON, M.D.

CONTENTS.

PAGE
Introductory ... 3

PART I.—THE PROGRESS OF SCARLET FEVER MORTALITY.

Scotland.—Mortality during Registration Years 1855-94:—
    In all Scotland ... 5
    ,, Urban and Rural Districts ... 5
    ,, Eight Principal Towns ... 6
England and Wales.—Mortality during Registration Years 1838-94:—
    In all England and Wales ... 6
    ,, Urban and Rural Districts ... 6
    ,, Counties ... 7
    ,, Twenty Great Towns ... 7
Ireland.—Mortality during Registration Years 1864-94:—
    In all Ireland ... 8
    ,, Urban and Rural Districts ... 8
    ,, Four Provinces ... 8
United Kingdom.—Comparison of Mortality ... 8
Relation of Mortality to Age and Sex (Scotland) ... 9
Relation of Mortality to Age Distribution of the Population (England and Wales) ... 9
Influence of Variation in the Composition of the Population as regards residence in Urban and Rural Districts (Scotland) ... 9

PART I.—*continued.*

PAGE
Scarlet Fever in other Countries:—
    Mortality in Sweden, Norway, and Denmark 10
    ,, German Empire ... 11
    ,, Other European Cities and Towns 11
    ,, United States of America ... 11
The Progress of Scarlet Fever Mortality compared with other diseases ... 13

PART II.—CAUSES OF DIMINUTION IN SCARLET FEVER MORTALITY IN GREAT BRITAIN.

Proximate Causes of Variation in Mortality... ... 13
Scarlet Fever Morbidity in English and Scottish towns where compulsory notification first adopted 14
Morbidity Rates compared with Mortality Rates ... 15
Scarlet Fever Fatality:—
    Fatality in Glasgow and London Hospitals ... 15
    ,, at different age periods in *ditto* ... 16
    Admissions to *ditto*—Percentage under 5 years of age ... 16
    Progress of Fatality in Glasgow and Metropolitan Hospitals compared with the Mortality in these cities ... 16
    General Fatality in notification towns ... 17
    ,, ,, compared with Mortality ... 17
    Comparison of Fatality and Mortality in one town with another ... 18
    Summary of results ... 18
Morbidity and Fatality in other Countries ... 19
Morbidity and Fatality in relation to:—
    Change in Type of Disease ... 20
    Influence of Preventive Measures ... 21
    Influence of General Sanitary Measures ... 22

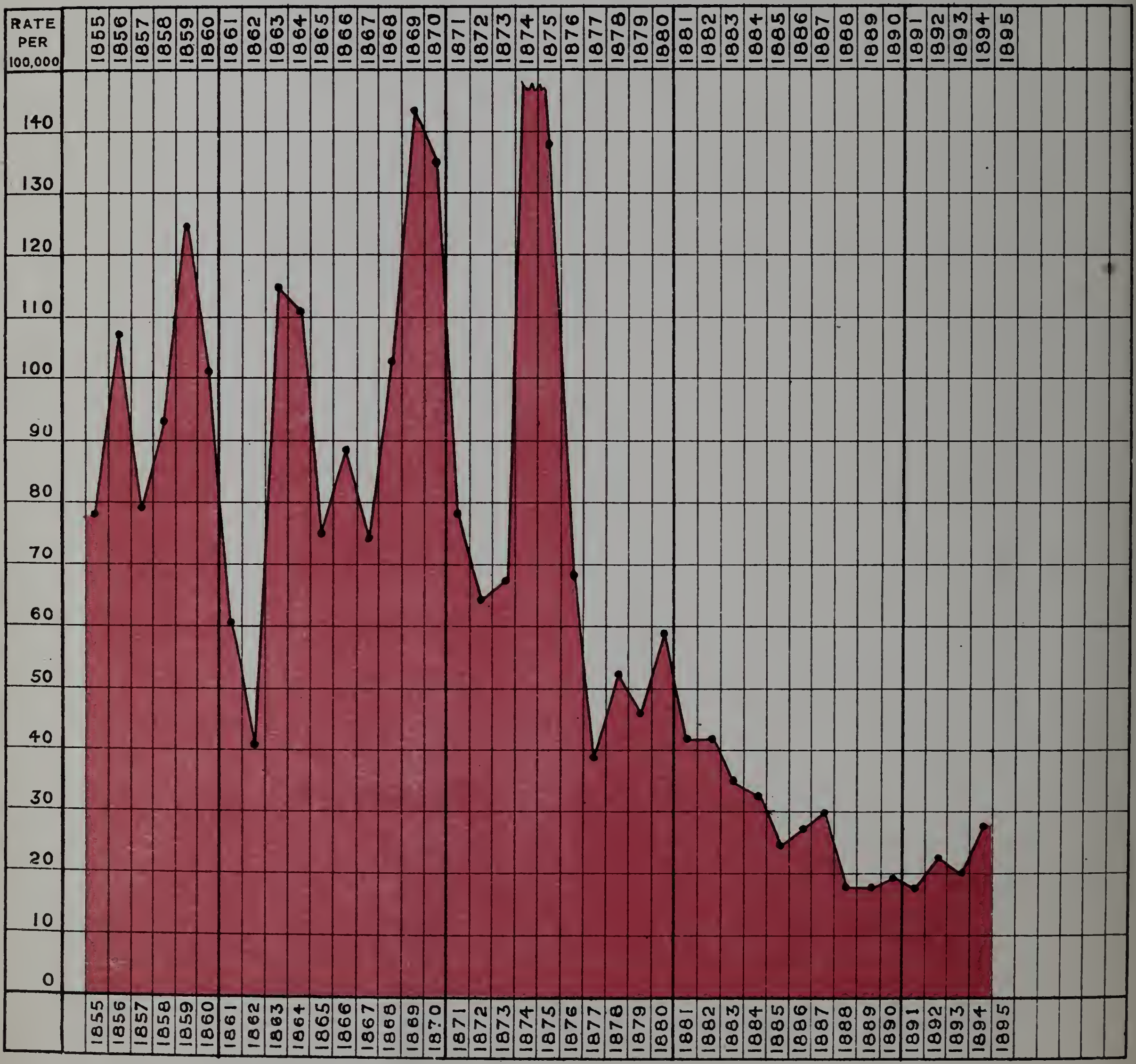
LIST OF ILLUSTRATIONS.

1. Scarlet Fever Mortality in Scotland Facing page 5
2. ,, ,, ,, England ,, ,, 6
3. ,, ,, ,, Ireland ,, ,, 7
4. ,, ,, ,, United Kingdom ,, ,, 8
5. Age Constitution of Population in England ... Facing page 10
6. General Mortality ... ,, ,, 13
7. Morbidity, Mortality, and Fatality ,, ,, 18

DIAGRAM I.

SCARLET FEVER IN SCOTLAND.

Death Rate per 100,000 of Population, 1855-1895.



PART I.

THE PROGRESS OF SCARLET FEVER MORTALITY.

SCARLET FEVER IN SCOTLAND.

Population in 1881, 3,745,485; *in* 1891, 4,033,180.

MORTALITY DURING REGISTRATION YEARS 1855-94.

IN ALL SCOTLAND.—The registered annual mortality from scarlet fever in Scotland during 1855-94 is shown in Diagram I. During the latter half of this period a great decline in mortality has occurred. It commenced about 1877, in which year the death-rate was 39 per 100,000 living, being the lowest recorded up till that time. From a study of the annual fluctuations which are less marked in the period of decline, it will be found that five years form a fairly reliable basis for comparing the death-rate of one period with another. By such a comparison we find that in the first four quinquennia—1855-74—the average annual death-rates from scarlet fever were 97, 86, 97, and 106; but in the four subsequent quinquennia—1875-94—the rates were 68, 42, 23, and 20 respectively per 100,000 of population.

As an aid to realising what an enormous saving of human life is represented by this reduction in the scarlet fever death-rate, we may make the following calculation:—During the twenty years—1855-74—the average annual death-rate was 96. What would the number of deaths have been had this rate of mortality continued during the subsequent twenty years ending 1894? We thus learn that the total lives saved during the last twenty years by the reduction in mortality from scarlet fever was 45,145. The death-rate is now only a fifth of what it was, the reduction from 96 to 20 being equal to 79 per cent.

IN URBAN AND RURAL DISTRICTS.—The districts into which Scotland is divided for registration purposes were first classified by the Registrar-General into three groups, namely, town, mainland-rural, and insular-rural districts. The two former were subsequently, in 1871, sub-divided, thus forming five districts in all, namely, principal towns, large towns, small towns, mainland-rural, and insular-rural districts. This grouping is extremely useful for public health purposes, especially in its distinguishing between urban and rural districts. The annual recorded mortality from scarlet fever in each group district shows a marked uniformity in the progress of the mortality in all the districts. From 1855 onwards fatal scarlet fever, even in the insular districts, is recorded each year in varying quantity. The last severe epidemic, which occurred in the years 1874-75, was felt in all the districts, and the fall in the death-rate which set in thereafter is also very marked in each district. These facts are evident in the following Table A, in which the death-rates are given for quinquennial periods and for the year 1855:—

TABLE A.—SCARLET FEVER IN ALL SCOTLAND, AND FIVE GROUPS OF DISTRICTS. DEATH RATES PER 100,000 POPULATION.

PERIOD.	ALL SCOTLAND	TOWN DISTRICTS.			RURAL DISTRICTS.	
		Principal.	Large.	Small.	Mainland.	Insular.
1855	78	99		71		10
1856-60	102	142		83		20
1861-65	81	113		65		23
1866-70	109	141		93		20
1871-75	106	142	126	115	64	26
1876-80	53	50	74	65	42	12
1881-85	35	47	42	39	17	6
1886-90	22	30	20	21	15	6
1891-93	20	28	18	17	12	5

If we compare the 1871-75 period with those of 1876-80 and 1881-85, we find that the reduction is most marked in the principal town districts; but by the next quinquennium the reduction in all five districts is almost alike, namely, about 80 per cent. The decline in the mortality from scarlet fever has, therefore, been felt in the country as well as in the town districts of Scotland, but was at first most marked in the principal towns.

IN THE PRINCIPAL TOWNS.—The group of principal town districts of the Registrar-General comprises Glasgow, Edinburgh, Dundee, Aberdeen, Leith, Paisley, Greenock, and Perth. The progress of the mortality in each of these towns can be studied from Table B, which gives the average annual death-rate for quinquennial periods and for the year 1855.

TABLE B.—SCARLET FEVER IN THE EIGHT PRINCIPAL TOWNS OF SCOTLAND. AVERAGE ANNUAL DEATH RATE PER 100,000 POPULATION, FOR QUINQUENNIAL PERIODS.

	1855.	1856-60	1861-65	1866-70	1871-75	1876-80	1881-85	1886-90	1891-95
Glasgow ...	58	140	123	141	145	52	66	38	35
Edinburgh ...	174	87	102	99	145	59	47	23	23
Dundee ...	10	159	163	200	158	28	14	33	6
Aberdeen ...	114	103	97	76	68	35	13	14	21
Leith ...	58	242	53	183	166	80	48	43	29
Paisley ...	93	195	93	152	167	88	56	20	18
Greenock ...	194	191	121	149	148	39	24	19	18
Perth ...	15	179	98	178	107	28	4	44	22

In each town a marked reduction in the rate of mortality occurred in the 1876-80 period, just as it occurred in Scotland generally. It will be observed that the sustained reduction appears in Aberdeen earlier than in the other towns.

If we take vigintennial rates, and arrange the towns in the order of their mortality, at each period we obtain the following result:—

TABLE C.—TOWNS ARRANGED IN THE ORDER OF THEIR SCARLET FEVER MORTALITY.

1856-75.		1856-75.		1876-95.		1876-95.	
Paisley	176	Perth	140	Leith	50	Greenock ...	26
Dundee... ...	170	Glasgow ...	137	Glasgow	48	Perth	25
Leith	160	Edinburgh ...	108	Paisley	45	Dundee ...	20
Greenock ...	150	Aberdeen ...	86	Edinburgh ...	38	Aberdeen	

The mortality within these two periods varies considerably in the different towns, and the reduction which occurs in the later period is more marked in some towns than others, as is indicated by the change in their relative positions—notably by Dundee and Greenock falling below Glasgow and Edinburgh. The reduction is least in Glasgow and Edinburgh, and greatest in Dundee.

SCARLET FEVER IN ENGLAND AND WALES.

Population in 1881, 26,061,736; *in* 1891, 29,082,585.

MORTALITY DURING REGISTRATION YEARS 1838-94.

IN ALL ENGLAND AND WALES.—The annual death-rates for All England and Wales are shown in Diagram II. The progress of mortality is similar to that for Scotland, both in amount and variation. The quinquennial death-rate per 100,000 population during 1856-95 was as follows:—

56-60	61-65	66-70	71-75	76-80	81-85	86-90	91-95
81	98	96	76	68	44	24	20

IN URBAN AND RURAL DISTRICTS.—Death-rates for groups of districts in England are only available for recent years, and are as follows:—

	All England.	Great Towns.	Large Towns.	Small Towns and Rural Districts.
1881-90	33	40	38	28
1891-95	20	25	22	16

DIAGRAM II.

SCARLET FEVER IN ENGLAND.

Death Rate per 100,000 Population. 1838-1895.

Up till the beginning of 1855 deaths registered Cynanche Maligna were included with Scarlet Fever.

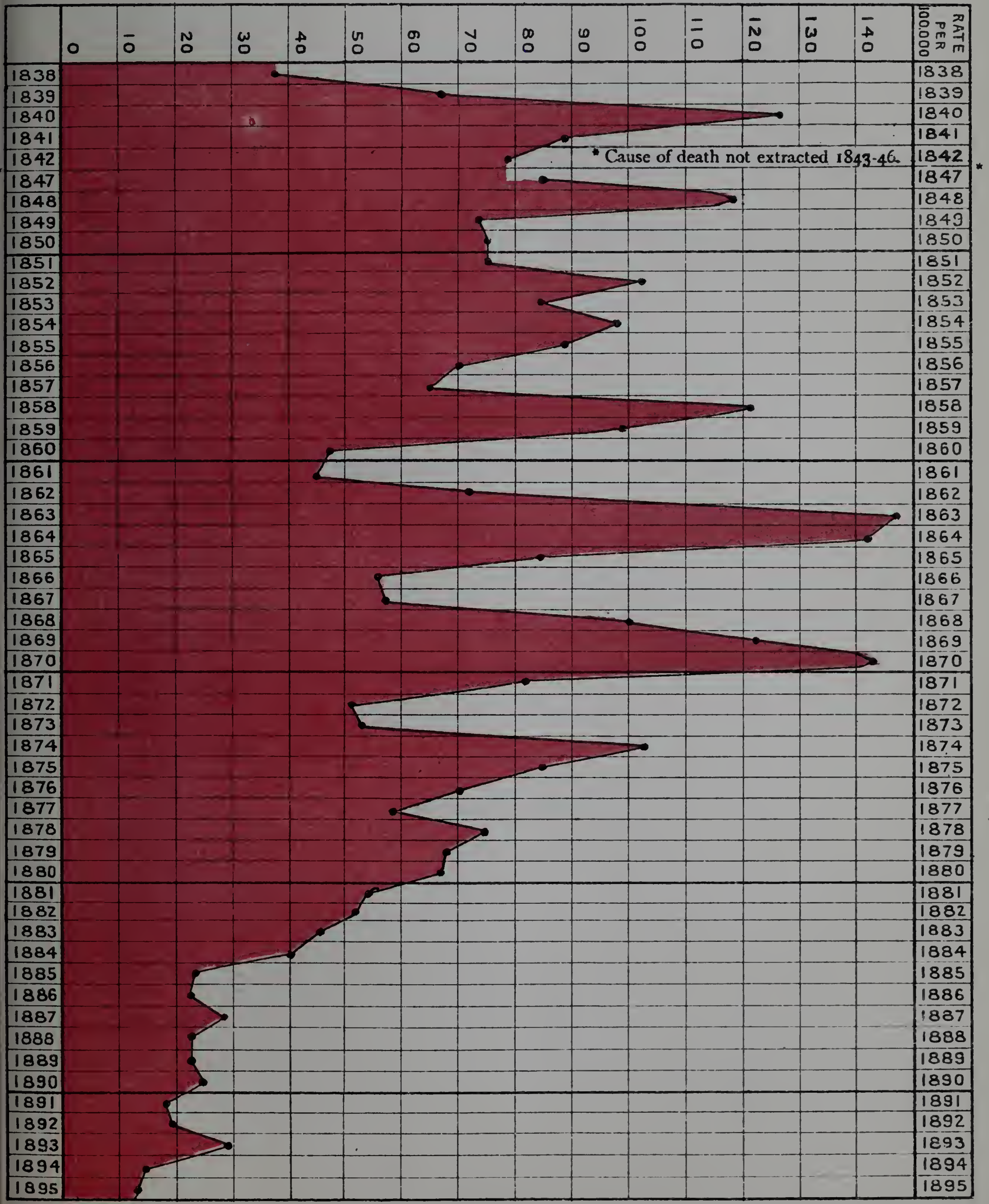
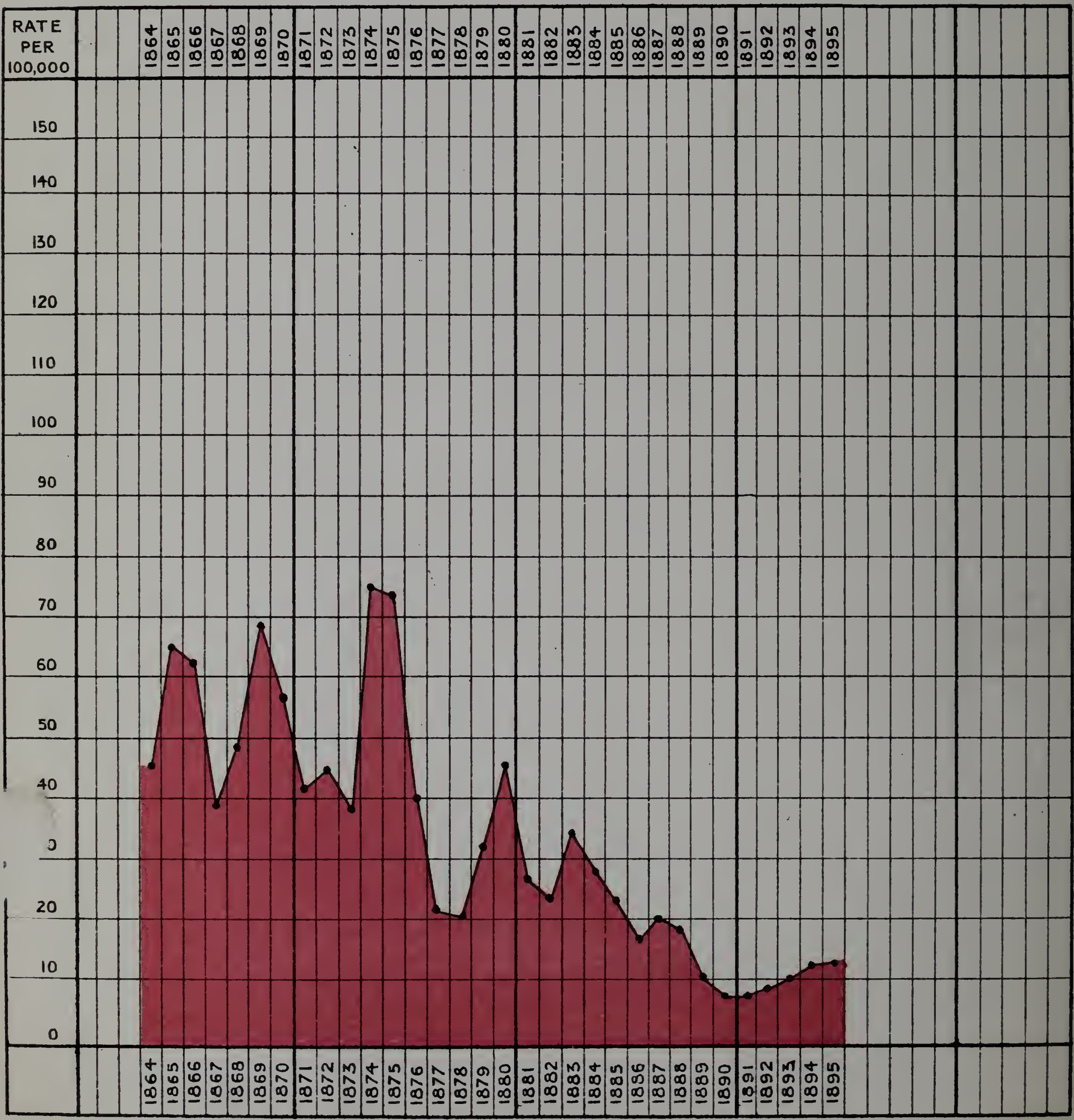


DIAGRAM III.

SCARLET FEVER IN IRELAND.

Death Rate per 100,000 Population, 1864-1895.



In order to provide somewhat similar data relating to the period prior to 1871, that is, prior to the decline in mortality, I have worked out for the period 1851-70 the death-rate in registration districts classified according to their density, after the method adopted by Longstaff. The result is as follows:—

England and Wales.	Great Towns.	Large Towns.	Small Towns and Rural Districts.
92	113	91	66

These figures show that in England, as in Scotland, the reduction in scarlet fever mortality has not been confined to one class of districts, but is almost equally manifest in all.

IN COUNTIES.—County death-rates have always formed an important feature of English statistics, and have sometimes been used to illustrate the differences between urban and rural mortality. For the two decades 1871-90 scarlet fever death-rates are given by the Registrar-General, and those for the previous two decades, 1851-70, I have calculated from available data.

The mortality varies greatly in the different counties, but a marked reduction during 1871-90 is manifest in all. Speaking generally, the reduction appears earliest, and is most marked in those counties with low or medium death-rates.

As has been pointed out by the Registrar-General, scarlet fever mortality is highest in the counties with a large mining and manufacturing population. These facts are evident in the following tables:—

SCARLET FEVER DEATH RATE IN COUNTIES, PER 100,000 LIVING, IN FOUR DECENNIA, 1851-90.

Counties with a large Mining or Manufacturing Population.					Counties with a large Agricultural Population.				
	1851-60	1861-70	1871-80	1881-90		1851-60	1861-70	1871-80	1881-90
Lancashire ...	136	136	133	48	Kent	63	74	34	15
Durham ...	119	162	138	52	Surrey ...	50	76	27	12
Northumberland	104	137	115	35	Sussex ...	57	57	23	12
West Riding ...	113	111	103	54	Hampshire ...	66	72	37	10

IN GREAT TOWNS.—From 1871 onwards the annual death-rates from scarlet fever in twenty great towns are obtainable (see Table D). In the first decennium, 1871-80, the death-rate per 100,000 varied from 25 in Plymouth to 159 in Oldham, and in 1881-90 from 13 in Portsmouth to 76 in Sheffield. The mortality in the latter decennium shows a marked decline in *all* the towns except Hull and Plymouth, in which the mortality was relatively low in the previous decennium.

TABLE D.—SCARLET FEVER IN TWENTY GREAT TOWNS. AVERAGE ANNUAL DEATH RATE PER 100,000 POPULATION FOR 1871-80, 1881-90, AND 1891-94.

	1871-80	1881-90	1891-94		1871-80	1881-90	1891-94
Sheffield	137	76	23	Hull	62	81	14
Oldham	159	41	19	Wolverhampton	92	31	28
Sunderland...	142	56	17	Leicester	66	42	23
Liverpool	117	62	34	Bristol...	73	35	15
Leeds	104	68	14	Nottingham	57	46	23
Newcastle	125	41	15	London	60	34	25
Manchester...	107	48	24	Norwich	55	18	11
Salford	108	62	34	Plymouth	25	44	26
Birmingham	108	33	16	Portsmouth	54	13	11
Bradford	110	31	37	Brighton	39	26	5

It will be observed that in England, as in Scotland, the great towns show great differences in their mortality from scarlet fever when compared with one another. As twenty years form a more reliable basis of time for such a comparison, I have prepared the following table:—

SCARLET FEVER IN TWENTY GREAT TOWNS, 1871-90, ARRANGED IN THE ORDER OF THEIR MORTALITY. AVERAGE ANNUAL DEATH RATE PER 100,000 POPULATION.

Sheffield ...	160	Newcastle ...	83	Birmingham ...	70	London ...	47
Oldham ...	100	Manchester ...	77	Wolverhampton...	61	Norwich ...	36
Sunderland ...	99	Salford	75	Leicester... ...	54	Plymouth ...	34
Liverpool ...	89	Hull	71	Bristol	54	Portsmouth ...	33
Leeds	86	Bradford ...	70	Nottingham ...	51	Brighton ...	32

SCARLET FEVER IN IRELAND.

Population in 1881—5,174,836; *in* 1891—4,681,248.

MORTALITY DURING REGISTRATION YEARS 1864-94.

IN ALL IRELAND.—Diagram III. gives the registered mortality from scarlet fever in the whole country. It also shows a great diminution, commencing as in Scotland, in the quinquennium 1876-80. The quinquennial rates per 100,000 population are as follows:—

1866-70	1871-75	1876-80	1881-85	1886-90	1891-94
55	55	32	27	14	10

IN URBAN AND RURAL DISTRICTS.—The material requisite for showing the progress of the mortality in rural and civic unions in Ireland is not supplied in the Registrar-General's reports. For the period 1881-90, the relative mortality from scarlet fever in two groups of districts was as follows:—

SCARLET FEVER MORTALITY IN CIVIC AND RURAL UNIONS, 1881-90. DEATH RATE PER 100,000 POPULATION.

All Ireland.	*Civic Unions.	Rural Unions.
21	34	15

*Civic Unions are those containing Towns with a Population of more than 10,000. All other Unions are Rural.

County rates are not, as in England, available, but Table E gives the deaths and death-rates, so far as obtainable, for the four Provinces, Leinster, Munster, Ulster, and Connaught.

TABLE E.—SCARLET FEVER IN THE FOUR PROVINCES, 1871-94. AVERAGE ANNUAL DEATHS AND DEATH RATES PER 100,000 POPULATION.

Period.	Leinster.		Munster.		Ulster.		Connaught.	
	Deaths.	Death Rates.	Deaths.	Death Rates.	Deaths.	Death Rates.	Deaths.	Death Rates.
1871-75	804	61	734	53	1111	61	278	34
1876-80	576	44	368	28	578	32	163	20
1881-85	362	29	438	33	523	30	49	6
1886-90	257	21·3	216	18	174	10·5	43	5·8
1891-94	97	8·2	50	4·3	188	11·6	110	13·1

The fall in the mortality is well marked in all the Provinces, and the rate is lowest in the most rural Province—Connaught.

SCARLET FEVER IN THE UNITED KINGDOM.

COMPARISON OF MORTALITY.—To facilitate comparison between the three countries, Scotland, England, and Ireland, Diagram IV. has been prepared, which shows the average annual death-rate from scarlet fever during registration years, arranged as far as possible in quinquennial periods.

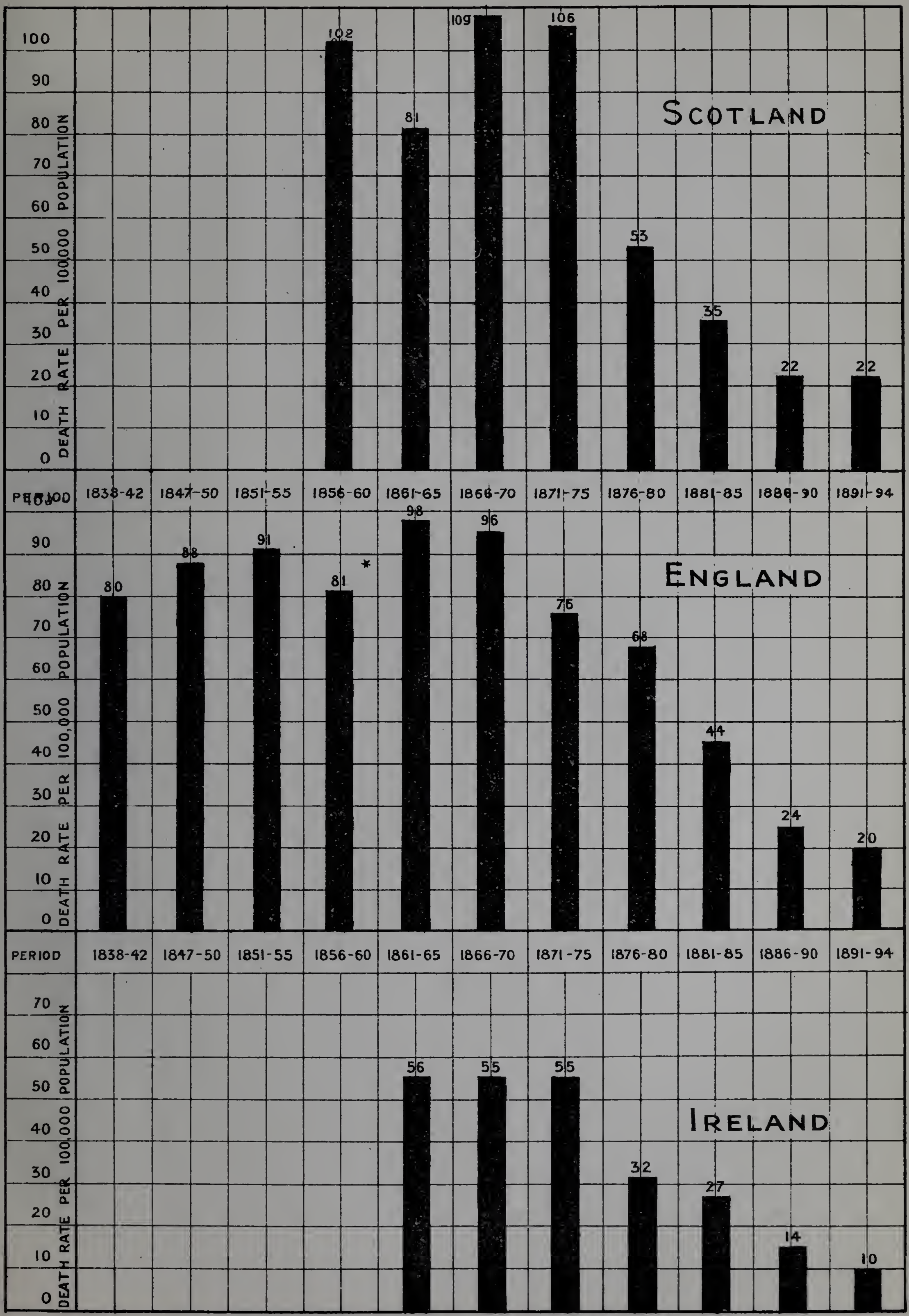
Comparing first the amount of scarlet fever mortality in each country, we observe that it is lowest in Ireland, while in Scotland and England the rates are about equal. In each country the range of mortality is great, being always highest in densely populated localities, and especially localities with manufacturing communities. This fact must be kept in view when comparing the scarlet fever mortality of Ireland with that of the sister countries, as Ireland possesses a much smaller proportion of large towns with manufacturing communities. In this connection it is also interesting to note that the birth-rate is lowest in Ireland, the average annual rates for the ten years, 1881-90, being: Scotland, 32·2; England, 32·3; and Ireland, 23·3 per 1,000 population.

The progress of the mortality in the three countries was markedly uniform, especially if we look at the decennial averages—uniform in the time of appearance, and in the extent of the reduction. The decline began in the Seventies, rapidly deepened in the Eighties, and still further in the Nineties.

The mortality from scarlet fever throughout the United Kingdom has, during the last twenty years, steadily fallen, until it is now 80 per cent. less than it was in the preceding registration period. The decline was general throughout each country, affecting both urban and rural districts, and the individual towns, so far as examined. I may here observe that the decline in scarlet fever mortality has not been confined to the United Kingdom. When we come to consider geographical distribution, it will be found that the progress of mortality in other European countries, and in the United States, shows a decline, which in some areas, as in the State of Massachusetts, is similar in time and amount to that in the United Kingdom.

DIAGRAM IV

SCARLET FEVER IN THE UNITED KINGDOM.



* The rate for Cynanche Maligna during this quinquennium was 4·5.

Before proceeding to enquire into the progress of scarlet fever in other countries, it may be well to consider some minor statistical questions arising out of those submitted.

Relation of Mortality to Age and Sex.—The mortality from scarlet fever in England, at different ages and age periods, has been ascertained by the Registrar-General. I have worked out the figures for Scotland, and find that they are similar to those for England. Thus the incidence of mortality upon males and females is almost the same. The death-rate at the different age periods varies considerably. By far the greatest incidence occurs during the first five years of life. In all the decennial periods (1861-90) the death-rates for the second, third, and fourth years are much higher than the others, and that for the third year is the highest of all, throughout Scotland.

The percentage of deaths occurring at early ages to total deaths at all ages is given in the following Table F, for the five groups of districts in Scotland, and for the period 1881-90.

TABLE F.—Percentage Deaths from Scarlet Fever, in Five Groups of Districts in Scotland, at Different Ages and Age Periods.

	Principal Towns.	Large Towns.	Small Towns.	Mainland Rural.	Insular Rural.
0—	6·4	8·7	7·7	6·6	7
1—	14·2	15·3	14·5	13·6	9·8
2—	15	16·5	15	15·6	14
3—	14·8	13.3	13·4	12·4	5·6
4—	11·6	12·2	11·2	10·8	8·4
0—5	62·3	66·3	61·5	58·6	45
5—	27·5	24	28·1	27·9	25·3
10—	6·2	5·5	5·8	6	11·2
15—	4	3·9	4	7·2	18·3
All Ages	100·	100·	100·	100·	100·

This shows that about 60 per cent. of the total deaths from scarlet fever occurs at ages under five years, except in the rural districts, where a somewhat greater proportion of deaths occurs at advanced ages. The figures for all Ireland are similar to those for the mainland rural districts of Scotland.

As to whether the decline in mortality has affected one age more than another, the following Table G shows that the small reduction in the decennium 1871-80, chiefly affected ages under five, but that, in the subsequent decennium, all ages benefited alike.

TABLE G.—Showing the Death Rate at Different Ages during the Last Two Decennia, Compared with the Rate in 1861-70 taken as 100. (All Scotland.)

	0—	1—	2—	3—	4—	0—5	5—	10—	15—	All Ages.
1861-70	100	100	100	100	100	100	100	100	100	100
1871-80	81	85	85	82	80	83	88	94	99	85
1881-90	32	35	33	32	31	32	32	35	37	32

Relation of Mortality to Age Distribution of the Population.—When death-rates are based upon the population at all ages, corrections are made for age distribution when comparing one district with another, but it is generally unnecessary to do so when comparing for the same district or area the death-rate of one period with another.

We learn from the last Census returns (1891) that—owing to the continued low birth rate—the increase to the population in England of children under five years was much less than usual, and in Scotland was *nil*. In Diagram V., which shows the actual increments to the population at different age-periods as ascertained from the last four Censuses of England and Wales, the comparatively small increase at the first and also the second age-period is evident. This affects the age constitution of the population by diminishing the proportion living under five years of age, which in 1881 was 13·6, and in 1891 was 12·3 per cent. of the total population.

A similar change in the age constitution of the population in Scotland has occurred; thus, in 1881, the percentage proportion under five years was 13·6, and in 1891 only 12·5 of the total population.

As scarlet fever mortality chiefly affects early age-periods, about 90 per cent of the total deaths occurring among children under ten years of age, it is necessary to make a correction on the death-rate at all ages when comparing the last inter-censal period with previous ones. The Registrar-General for England calculates that seven per cent. of the reduction in the scarlet fever mortality is due to this statistical cause.

Influence of Variation in the Composition of the Population as Regards Residence in Urban and Rural Districts.—As the urban death-rate is higher than the rural, any change in the distribution of the population in regard to residence in urban and rural districts will affect the rate for the whole country, independently of any other cause. The percentage proportion of the population of Scotland living in urban and rural communities, as ascertained at the three last Censuses, is as follows:—

TABLE H.

	Principal Towns.	Large Towns.	Small Towns.	Mainland Rural.	Insular Rural.
1871	31·8	9·9	23·2	31·2	3·9
1881	37·7	10·7	21·1	27·1	3·4
1891	39·4	11·6	20·8	24·8	3·1
1871	41·7		54·4		3·9
1881	48·4		48·2		3·4
1891	51·1		45·4		3·1
	Increase 10 %		Decrease 9 %		Decrease 0·8 %

This shows that the proportion of the population living in the principal and large towns has increased about 10 per cent., while the proportion living in small towns and rural districts has undergone a corresponding decrease.

If, therefore, the rate at which people died from scarlet fever had remained stationary in urban and rural districts, the change as above indicated in the relative proportion of urban to rural population would have increased the death-rate for all Scotland to a small extent, other things being equal.

The change in the age constitution of the population at last Census, and the change in the relative proportion of urban and rural population, tend to neutralise each other in their effect on scarlet fever mortality.

SCARLET FEVER MORTALITY IN OTHER COUNTRIES.

Regarding the geographical distribution of scarlet fever, Hirsch says, " By far the largest area of distribution is met with on European soil, where—especially in its central and northern parts—its frequency presents a striking contrast to its very scanty diffusion hitherto in Africa and Asia."

Statistics from countries representing the above distribution are, in the absence of an international statistical bureau, difficult to collect, but such as I have been able to obtain are here set forth.

SCARLET FEVER MORTALITY IN EUROPEAN COUNTRIES.

Death Rates per 100,000 Population.

Sweden. *Population* (1891), 4,793,866.

In All Sweden.—

Period	1861-70	1871-80	1881-90	1891-94
Rate	69·9	78	50·4	31·2

In Stockholm. *Population* (1891), 248,491—

Period	... ...	1871-80	1881-90	1891-95
Rate	... ...	83·8	62·9	61·9

Calculated from data obtained from Le Bureau Central de Statistique de Suéde.

Norway. *Population* (1890), 1,985,000.

In All Norway—

Period	1862-70	1871-80	1881-90	1891-93
Rate	30·5	51·5	35·5	11·8

In Christiania. *Population* (1891), 156,535—

Period	1861-70	1871-80	1881-90	1891-95
Rate	87	71	68	25

Calculated from data contained in " Beretning om Folkemaengden og Sundhedstilstanden."

Denmark.

In Copenhagen. *Population* (1890), 312,859—

Period	1865-74	1875-84	1885-94
Rate	63	30	30

In Other Danish Towns. *Aggregate Population* (1890), 409,385—

Period	1865-74	1875-84	1885-94
Rate	62	38	14

Calculated from data obtained from the Royal Danish Statistical Office.

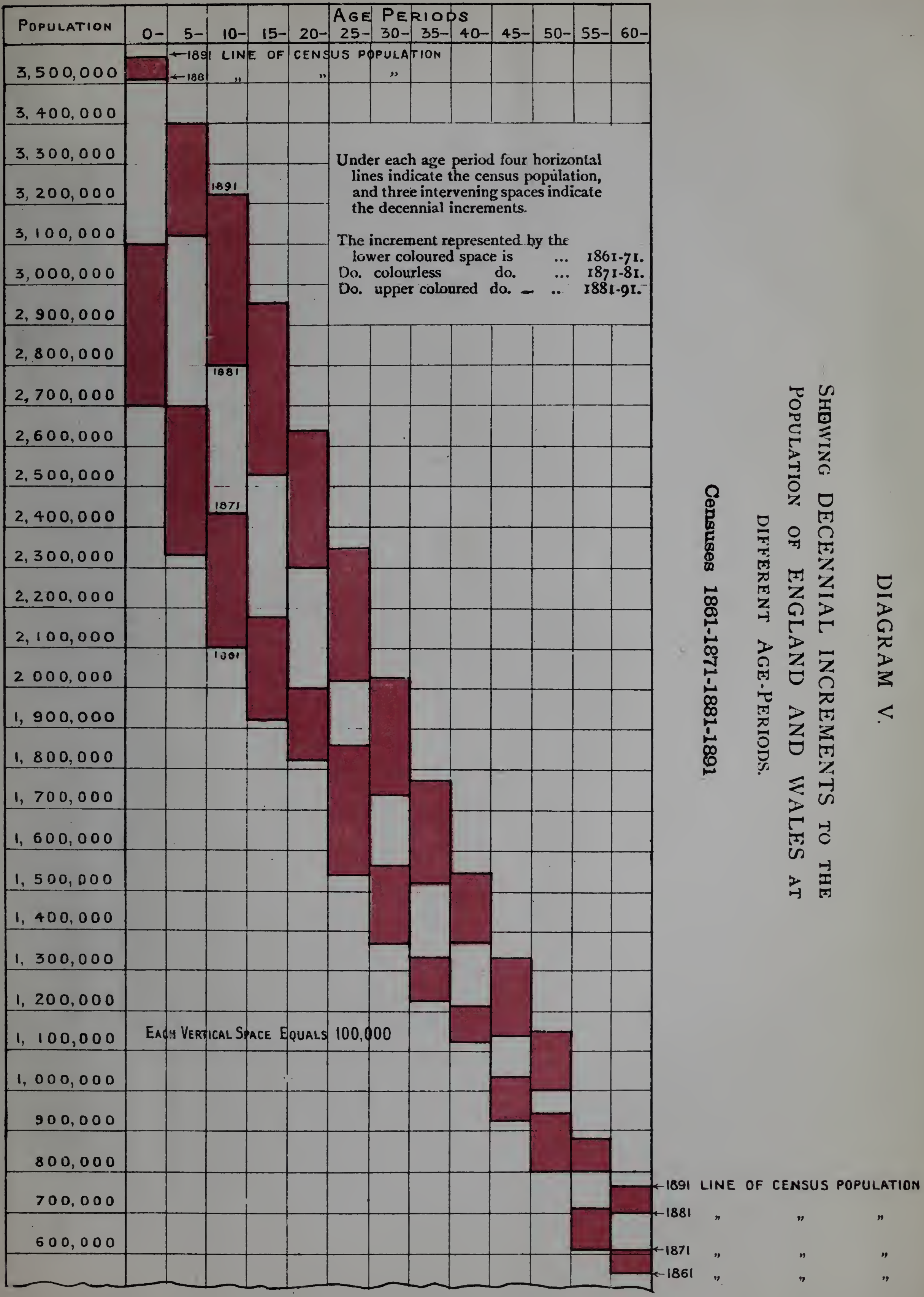


DIAGRAM V.

SHOWING DECENNIAL INCREMENTS TO THE POPULATION OF ENGLAND AND WALES AT DIFFERENT AGE-PERIODS.

Censuses 1861-1871-1881-1891

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GERMAN EMPIRE.

ALL GERMAN TOWNS WITH A POPULATION OF 15,000 AND UPWARDS. *Aggregate Population* (1891), 11,515,139—

Period	1877-84	1885-89	1890-94
Rate	48	27	18

Calculated from data contained in the "Statistische Jahrbücher für das Deutsche Reich."

In all these countries there is evidence of a decline in scarlet fever mortality. In Norway and Sweden it is later in occurring, and in Stockholm the amount of reduction is very small.

OTHER EUROPEAN CITIES AND TOWNS. DEATH RATES PER 100,000 POPULATION.

	1879-86	1888-94		1879-86	1888-94		1879-86	1888-94
Moscow	—	63	Vienna	25	18	Turin	10	8
St. Petersburg ...	65	—	Hague	16	10	Rome	14	4
Buda-Pesth... ...	45	33	Rotterdam... ...	30	14	Brussels	8	2
Trieste	22	24	Amsterdam ...	30	3	Paris	10	8
Prague	54	35	Venice	4	3			

Calculated from data taken from the Annual Summaries of the Registrar-General of England.

From the foregoing it would appear that the mortality is heaviest in the towns of Northern Europe; the highest average rates in recent years being those of Stockholm, St. Petersburg, and Moscow, which are all above 60, while in Paris, Brussels, Rome, Turin, and Venice, the rates are under 10 per 100,000 population.

The small mortality from scarlet fever in Sout[illegible] Europe, and the comparative absence of the disease in Asia and Africa, lead one to ask whethe[illegible] distribution is governed by climatic influences or by racial distinctions.

This is a question which to some extent the statistics of the United States, where different races are to be found living under the same climatic conditions, may assist in answering.

The geographical distribution of scarlet fever is a most important feature of its natural history, and contrasts markedly with that of measles and small-pox.

SCARLET FEVER IN THE UNITED STATES OF AMERICA.

The United States has no national system of registration of vital statistics, such as obtains among other civilized nations. In 1880 only two States, one district and nineteen cities, possessed State and municipal registration records, based on a system of burial permits, and therefore probably very nearly accurate.

The mortality of the United States is only known for Census years—not for a continuous series of years—and death rates from particular diseases, such as scarlet fever, are expressed in terms of the total deaths from all known causes, as follows :—

Census Year 1860, Deaths from Scarlet Fever, 66·9 per 1,000 Deaths from all Causes.
,, ,, 1870, ,, ,, ,, ,, 41·2 ,, ,, ,, ,,
,, ,, 1880, ,, ,, ,, ,, 21·6 ,, ,, ,, ,,

Taken from the Tenth Census of the United States (1880), Vol. XII. "Mortality and Vital Statistics," Part II., p. xxix.

Considering that the general death-rate per 1,000 population was in 1860, 12·5, in 1870 12·7, and in 1880, 15·0, also that the figures relate to a population of about fifty millions, such death-rates are of value as an indication of the scarlet fever mortality during the three Census years, which, it is worthy of note, shews a marked decline. Scarlet fever death rates thus constructed, and for three isolated years, cannot of themselves be accepted as representing the progress of the mortality from this disease during the period embraced. But from what follows it is probable that these figures do indicate the progress of mortality in intercensal years.

Vital statistics for a series of years are obtainable from the Annual Reports of the individual State or municipal Boards of Health, and tables prepared from such of these reports as I have been able to procure are here given.

States of Massachusetts and Rhode Island.—The yearly mortality in these States will be found in the following Table I., in which the average death-rates in the one case, and average annual deaths in the other, for quinquennial and decennial periods are given :—

TABLE I.

Massachusetts.			Rhode Island.		
Scarlet Fever Mortality.			Scarlet Fever Mortality.		
Period.	Death Rates per 100,000 Population.		Period.	* Average Annual Deaths.	
1858-60	90		1855-60	119	
1861-65	97	82	1861-65	143	121
1866-70	67		1866-70	99	
1871-75	86	62	1871-75	211	206
1876-80	40		1876-80	201	
1881-85	27	22	1881-85	81	103
1886-90	17		1886-90	126	
1891-94	25		1891-93	59	

* Death Rates not obtainable.

The amount and progress of the mortality in Massachusetts is similar to that in the United Kingdom. In Rhode Island (allowing for increase of population) there is also a marked reduction, but it is later in appearing.

States of Connecticut, New Hampshire, and Minnesota.—The following Table J. shows that the mortality from scarlet fever during recent years is low in these States, and that in Connecticut, where the period is long enough to admit of comparison, we have evidence of a marked decline.

TABLE J.—Average Annual Death Rate per 100,000 Population.

Period.	Connecticut.	Period.	New Hampshire.	Period.	Minnesota.
1876-85	34·1	1884-87	10	1887-91	16
1886-94	18·3	1888-92	6		

American Cities.—The average annual mortality for quinquennial periods is as follows :—

TABLE K.—Scarlet Fever Death Rate per 100,000 Population.

	1871-75	1876-80	1881-85	1886-90	1891-94
New York ...	86	89	90	52	42
Brooklyn	—	82	86	41	36
Philadelphia ...	—	50	50	24	28
Baltimore	—	96	42	12	28
*San Francisco ...	70	10	8	4	11

* In the period 1866-70 the rate was 69.

The mortality from scarlet fever in the above towns during the last ten years is about 50 per cent. less than in the preceding years, except in San Francisco, where the decline is greater and occurs earlier.

In the Tenth Census of the United States, speaking of the geographical distribution of scarlet fever, Billings says : "The mortality from this disease was very low in the Southern States, with the exception of that part of Arkansas lying on the Mississippi River ; but this may be due to a great extent to the large proportion of coloured population in this region, *a class in which the mortality from this disease appears to be very low.*"

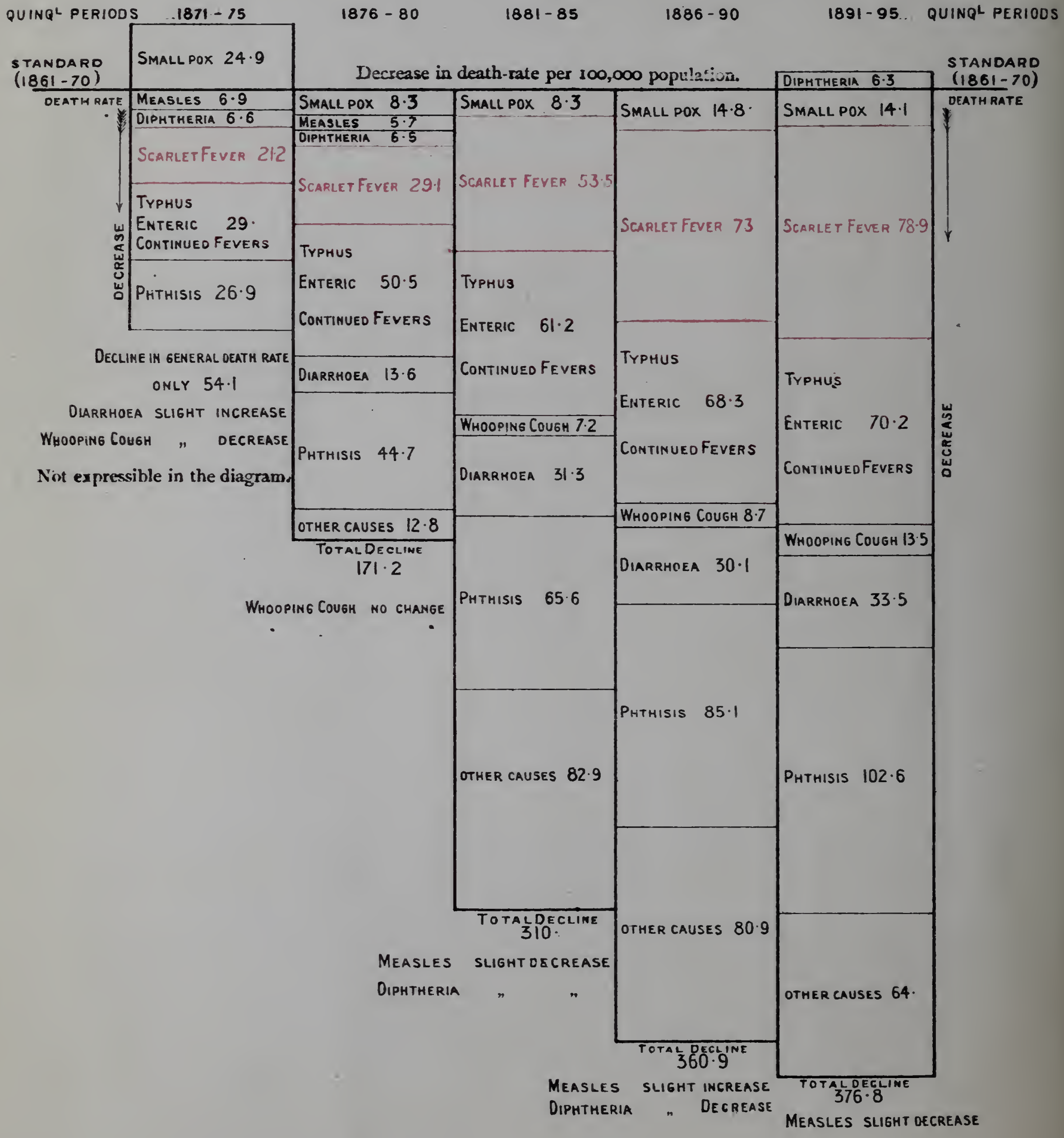
The following is taken from Vol. I., Table 14, showing for white, coloured, and Indian the proportion of deaths from certain specified causes per 1,000 total deaths of which the causes are known.

	Whites.	Coloured.	Indians.
Scarlet Fever	28·05	5·15	10·46
Measles	12·12	23·75	61·78
Diphtheria	52·63	23·27	37·36

DIAGRAM VI.

SHEWING DECLINE IN DEATH RATES FROM "SEVEN PRINCIPAL ZYMOTIC" DISEASES, PHTHISIS, AND ALL OTHER CAUSES DURING 1871-95 IN ENGLAND AND WALES.

The rates in each quinquennial period are compared with those for 1861-70, and the difference is expressed in figures and diagrammatically by the depth of the column under or above the standard line.



Again, in Vol. II., p. xxx.: "In those parts of the country in which the distinction of colours and parentage was made, it (scarlet fever) caused a much greater proportion of deaths among the whites than among the coloured."

More valuable statistics are forthcoming in the Eleventh Census (1890), where death-rates based upon population are to be found.

Thus from the volume dealing with Boston and Philadelphia the following is obtained:—

Average Annual Death Rates, per 100,000 Population, for the Six Years ending May 31st, 1890, from Scarlet Fever.

Boston.		Philadelphia.	
White.	Coloured.	White.	Coloured.
36·8	10·0	26·8	9·8

These statements and figures would lead us to believe that Negroes and Red Indians are less liable to the disease than whites. The liability to scarlet fever depends chiefly upon susceptibility to the disease and exposure to its infection. Should it be the case that the coloured races were equally exposed to infection with the whites, and that the age constitution of the different races were similar, then it might be concluded that the coloured races are less susceptible to scarlet fever than the whites.

THE PROGRESS OF SCARLET FEVER MORTALITY COMPARED WITH OTHER DISEASES.

No attempt at an explanation of the reduced mortality from scarlet fever could be considered complete which did not take into account the progress of mortality from other and similar diseases. It may, then, at this stage be advisable to consider the information set forth in Diagram VI., which shows how the quinquennial rates of mortality during 1871-95 have varied from the rates of 1861-70 for all causes, the seven chief zymotics, and phthisis. The mortality rates for each of the diseases compared show some evidence of a decline, which in the case of diphtheria, measles, and whooping-cough is trifling and unsteady, and contrasts very strikingly with the progress of the mortality from scarlet fever, "fever"* and phthisis. Note the influence of these different diseases upon the general mortality, which has shown a steady cumulative decline, until the reduction in 1891-95 was 376 per 100,000 from all causes. This reduction might be summed up as follows:—Phthisis, 103; scarlet fever, 79; "fever," 70; diarrhœa, 33; small-pox, 14; whooping-cough, 13; measles, 3; diphtheria, *nil*; and the balance of other causes 64. With the exception of phthisis, no disease has contributed more to the reduction in the general death-rate during the past twenty-five years than scarlet fever, and its association in this respect with "fever" and phthisis is a circumstance which should be kept in view. Other causes expresses the balance of increase and decrease in all other diseases.

PART II.

CAUSES OF DIMINUTION IN SCARLET FEVER MORTALITY IN GREAT BRITAIN.

Proximate Causes of Variation in Mortality.—Variations in scarlet fever mortality depend immediately on the prevalence of the disease, and its tendency to prove fatal. The death-rate is the resultant of two factors, the morbidity-rate and the fatality-rate. The former indicates the quantity, the latter is generally believed to indicate the quality or *type of disease*, which from its earliest recognition in this country has been known to vary greatly during the course of an epidemic, and in comparing one epidemic with another; hence the nomenclature, Scarlatina Simplex,

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* "Fever" includes typhus, enteric, and simple and ill-defined.

S. Anginosa, and S. Maligna. The morbidity-rate is generally considered the most powerful factor in producing annual fluctuations of mortality—but this may not be so, as witness the following.[*]

SCARLET FEVER MORTALITY IN EDINBURGH, WITH MORBIDITY AND FATALITY RATES.

	Death Rate per 100,000 Population.	Morbidity Rate per 10,000 Population.	Fatality per 100 Cases.
1881	110	84	13
1882	38	90	4

Here is a reduction of mortality amounting to about 70 per cent. without any diminution in prevalence, and evidently due to a decrease in fatality. It will therefore be necessary, first, to ascertain whether the reduction in mortality is due to a diminished prevalence or diminished fatality, or both. Seeking to determine the respective influences of these two factors, let us proceed to consider to what extent the diminished mortality is due to diminished prevalence.

MORBIDITY IN SCOTLAND AND ENGLAND.—Registration of sickness by compulsory notification of infectious disease only became general throughout Great Britain during the last five years, and although in operation in a few towns prior to this, even these localities do not possess records which go further back than 1881. It is therefore impossible to compare, by reliable statistics, the prevalence of scarlet fever before the diminution in mortality began with the prevalence since that time, and thus directly ascertain to what extent the diminution in mortality is due to diminished prevalence of the disease.

If we examine the records of morbidity available, we find that scarlet fever is still a very prevalent disease. In the year 1892 this disease was notifiable in 86 per cent. of the total population of England and Wales, for which the incidence rate, as ascertained by Ernest Hart, was 49·8 per 10,000[†]; in 81 urban districts of England and Wales, with a population of 12,000,000, the incidence for 1893 was 68, and for 1894 was 43. In Scotland the rate for all urban and rural districts under notification (over 3,000,000), in 1892, was 56; in 1893, 50; in 1894, 56; and in 1895, 56 per 10,000 population.

From statistics relating to towns in England and Scotland where notification has been in operation for some time (obtained by Professor Matthew Hay, from the various medical officers of health), I have calculated that the average annual morbidity-rate for the last ten years or so, in each of the large towns, varied from 32 to 60 per 10,000. From these statistics I have also prepared Table L, in which we can compare the average annual cases notified during 1891-94 with the average for the two preceding quinquennia, or for the whole period. Although statistics extending over such a short period do not form a very satisfactory basis for comparison, yet, after making allowance for increase of population and epidemic periodicity, they seem to show that there has been no very marked decline in prevalence during the last fourteen years in these towns.

TABLE L.—SCARLET FEVER MORBIDITY IN ENGLISH AND SCOTTISH TOWNS WITH COMPULSORY NOTIFICATION.
AVERAGE ANNUAL CASES NOTIFIED.

Town.	1881-85.	1886-90.	1891-94.	Whole Period, 1881-94.	Town.	1881-85.	1886-90.	1891-94.	Whole Period, 1881-94.
Edinburgh	1,678	1,393	1,571	1,569	Newcastle	‡1,513	835	816	998
Dundee	†390	1,346	253	716	Nottingham	†558	728	1,183	815
Aberdeen	†354	467	709	506	Oldham	344	830	403	498
Birkenhead	†288	496	299	372	Salford	‡863	1,272	814	1,034
Halifax	†186	354	237	266	Bradford	—	784	1,147	945
Huddersfield	171	356	434	312	Portsmouth	—	551	746	638
Leicester	995	429	1,322	894	Sunderland	—	555	632	589
Manchester*	†1,318	2,020	1,768	1,726					

* Population area increased in last two quinquennia.
† Notification began 1882.
‡ ,, ,, 1883.

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[*] See also the Milroy Lectures on "Changes of Type in Epidemic Disease." By B. Arthur Whitelegge, M.D., B.Sc., 1893-94.

[†] "Essays on State Medicine: Compulsory Notification in England and Wales," 1892.

In the following Table M we can compare the average annual morbidity rates with the mortality rates in six towns.

TABLE M.

	Cases Notified per 10,000 Population.			Deaths Registered per 100,000 Population.		
	1881-85	1886-90	1891-94	1881-85	1886-90	1891-94
Aberdeen ...	32	40	55	15	14	20
Edinburgh ...	70	53	60	47	23	22
Leicester ...	76	30	72	69	13	23
Manchester ...	24	39	34	46	50	24
Oldham ...	30	60	30	37	40	19
Nottingham ...	24	31	51	44	11	23

From this we learn that in the above towns the average morbidity rate for quinquennial periods bears no constant relation to the mortality rate for the same period; that marked reductions in mortality have occurred without any or very little reduction in the prevalence of the disease. In Aberdeen the mortality has slightly increased, and the morbidity more so. In Nottingham the morbidity has increased, although the mortality has fallen. Records of morbidity, however, are too meagre to afford conclusive evidence as to whether the general reduction in scarlet fever mortality is due to diminished prevalence of the disease, but such evidence as we have suggests a negative answer to this question.

I have not criticised the value of these notification statistics as an exact measure of the prevalence of scarlet fever. Their value is not likely to vary from year to year, and so long as the deductions are made on a broad basis, they are, I believe, reliable. Possibly some cases are notified now as scarlet fever which a few years ago would have escaped notification, owing to more accurate diagnosis through the fulfilment of the legal obligation put upon medical practitioners by the Notification Act. Still it is notorious that owing to the prevailing mildness of this disease in recent years, many cases escape recognition, especially in rural districts, where medical aid is more difficult to procure than in towns.

Hospital Fatality.—It is a matter of common experience, in both general and hospital practice throughout Great Britain and elsewhere, that the average tendency of scarlet fever to prove fatal has diminished in recent years. Of this diminished fatality statistical evidence, both general and clinical, may be obtained from hospital records. Fatality rates are also obtainable from the notification returns prepared by health officers, but the hospital records are the more valuable, and will be first considered.

The fever hospitals of the Metropolis and those of the City of Glasgow are the most extensive in Great Britain. Statistics relating to scarlet fever fatality in these hospitals are given in Table N (obtained from Dr. Russell's "Sanitary History of Glasgow," and the reports of the Statistical Committee of the Metropolitan Asylums Board.)

TABLE N.

City of Glasgow Fever Hospitals.				Metropolitan Asylums Board Hospitals.		
Period.	Cases.	Deaths.	Per cent. Fatality.	Cases.	Deaths.	Per cent. Fatality
1871-75	1,697	260	15·3	2,186	266	12·2
1876-80	1,568	195	11·7	5,247	688	13·0
1881-85	4,411	525	11·9	8,445	955	11·3
1886-90	5,359	479	8·9	23,143	2,017	8·7
1891-94	9,853	621	6·3	44,501	2,814	6·3
1895	2,488	138	5·5	11,271	591	5·4

The average fatality rate for quinquennial periods here given is calculated from the total cases and deaths for the period. The number of cases removed to hospital has increased in each period, and at the same time there has been a marked decrease in the fatality rate. It is believed that hospital fatality depends, to some extent, upon the class from which the patients are drawn. As hospital isolation has, in recent years, been largely patronised by people living in good circumstances, it is possible that this may have had some influence in reducing fatality, but I have no evidence to submit.

In considering the decline in hospital fatality, it is necessary to bear in mind that the tendency of scarlet fever to prove fatal depends largely upon the age of the patient. This is shown in the following table :—

SHOWING PERCENTAGE FATALITY AT VARIOUS AGES OF 92,615 CASES ADMITTED INTO THE ASYLUMS BOARD'S HOSPITALS IN THE YEARS 1871-95.

Ages 0—5	5—	10—	15—	20—	25—	30—	35—	40 upwards.
16·9	5·0	2·2	2·4	2·5	2·8	4·3	5·0	6·0

The fatality at ages under five years being so enormously higher than at subsequent ages, it is evident that the fatality in a given number of cases admitted to hospital will vary directly with the proportion it contains under five years of age, and that in this way the decline in fatality above observed may be accounted for. Such, however, is not the case, as the following calculation, made from Asylums Board statistics, shows :—

ADMISSIONS TO HOSPITAL.

Period.	Total.	Under 5 years.	Percentage under 5 years.
1871-86	15,480	4,112	26·5
1887-89	14,826	4,415	29·
1890-91	11,799	3,548	30·
1892-95	50,510	14,462	28·6

The total cases admitted to the Metropolitan hospitals in the first period contained a smaller proportion of cases under five years of age than in any period since. One may also assume that this is true of the admissions to Glasgow hospitals, and conclude that the reduction in fatality in these hospitals has not been due to a variation in the age incidence of the cases admitted.

The following Table O compares the hospital fatality with the mortality for the whole city in each case.

TABLE O.

	GLASGOW.				LONDON.					
	Hospital Fatality* per 100 Cases.		City Mortality per 100,000 Population.		Hospital Fatality* per 100 Cases.				City Mortality per 100,000 Population.	
Period.					Fever Hospital.		Asylums Board Hospitals.			
1861-65	—		—		14.1	12.6	—		112	
1866-70	20·3		141		11·1		—		115	
1871-75	13·8	12·6	145	88	10·3	10·5	10·8	11·7	57	54
1876-80	12·2		52		11·5		13·2		62	
1881-85	11·7		66		9.8		11·2		42	
1886-90	8·8	7·5	38	36	4·2	3·0	9·0	7·7	25	25
1891-94	6·3		35		1·8		6·5		25	

* The arithmetical mean of the rate for each year.

SHEWING THE PERCENTAGE REDUCTION IN FATALITY AND MORTALITY DURING THE PERIOD 1886-94, AS COMPARED WITH THE PERIOD 1871-85.

Percentage	Fatality.	Mortality.		Fatality.	Mortality.
Reduction	40·5	59		34	53·7

It may be remarked that in the above comparison I am contrasting a fifteen-year period with a nine-year period, but it will be seen from Table N that the total cases dealt with, or units compared, in the fifteen-year period are much smaller than in the nine-year period.

The cases dealt with in years prior to 1871 are so few that I hesitated to employ them in making such an important comparison. It will, however, be observed that the fatality was highest in the furthest back periods, and amounted to 20 per cent. in Glasgow, where it now is only 6·3 per cent.

In thus dividing the whole period to which these hospital statistics refer, my only object was to obtain reliable data for comparison. The comparison thus made shows that the mortality-rate has fallen 50 to 60 per cent., while the fatality-rate has fallen 30 to 40 per cent.

In this way it is possible to account for 65 per cent. of the reduction in scarlet fever mortality during the period 1886-94; that is, assuming that the reduction in the fatality of cases treated outside the hospital corresponded to the reduction in the fatality among those treated within the hospital.

Hospital fatality may not always be a measure of the general fatality (that is, the fatality represented by the total cases and deaths occurring within the district served by the hospital), but at present it is so in Glasgow, and also—though to a less extent—in London. Thus in Glasgow, during the years 1891-94, the general fatality-rate, based upon the total number of cases notified and deaths registered—which includes hospital cases—was 6.2 per cent., while the hospital fatality-rate was 6·3. In London for the same period the general fatality-rate was 4·7, while the hospital rate was 6·3. It will also be observed that in the London (Private) Fever Hospital, which draws its cases from a different class of the community than the Asylums Board does, although the fatality is lower in the former, the progress of the fatality is similar. In Liverpool, more than one-half of the cases are treated at home, and fatality-rates for these cases and those treated in hospital are given separately for the years 1891-95. The rates per cent. are as follows:—

Home fatality—	11·6	9·3	6·9	6·0	5·8
Hospital fatality—	6·0	5·6	5·3	5·4	6·9

These figures show a marked decline in the home fatality. On the whole, we may conclude that the reduction in scarlet fever fatality observed in Glasgow and London was not confined to hospital cases, but that it was general throughout the two communities.

General Fatality.—For statistics of fatality in bygone years we seem chiefly indebted to dispensary physicians. The following may not possess much practical interest, yet they are worthy of consideration. At Newcastle Dispensary, in 1778, Clark records 95 cases of scarlet fever, of which 13 proved fatal, giving a case fatality of 14 per cent. At Birmingham Dispensary, in 1834-39, Rylands records 238 cases with 33 deaths, a fatality of 14 per cent. At Reading Dispensary, Cowan records, in 1842-44, 84 cases and 13 deaths, giving a fatality of 15 per cent.

From the records of cases and deaths in notification towns I have prepared Table P, which gives the general fatality along with the mortality for recent years—periods subsequent to 1880. These records shew that there is an intimate relation between fatality and variations in mortality. In most towns there has been a decline in mortality during this period, and where this is marked, there has been a corresponding decline in fatality; whereas in a few towns where the mortality had fallen to its minimum, prior to 1880, there has been no reduction in fatality. As examples, take the quinquennial rates in Manchester or Newcastle where the two rates have fallen, and Aberdeen, where both mortality and fatality rates remain almost the same in the whole period under review.

A decline in the average mortality seems associated with a decline in the average fatality.

TABLE P.—Scarlet Fever Mortality and Fatality.

	1881-5.		1886-90.		1891-94.	
	Mortality per 100,000 Population.	Fatality. per 100 Cases.	Mortality per 100,000 Population.	Fatality per 100 Cases.	Mortality per 100,000 Population.	Fatality per 100 Cases.
Edinburgh	47	6·3	23	4·0	23	3·7
Dundee	10	3·6	33	3·8	6	3·3
Aberdeen	15	4·6	14	3·1	20	4·0
Birkenhead...	27	8·3	38	7·7	10	3·0
Bradford	—	—	29	8·4	37	7·2
Halifax	30	12·	23	5·7	15	3·9
Huddersfield	15	7·5	26	7·	24	5·5
Leicester	69	10·	13	4.5	23	3·2
Manchester...	46	13·	50	12·	24	7·
Newcastle	78	8·	20	4·	15	3·6
Nottingham	44	18·	11	3·4	23	4·3
Oldham	37	12·7	40	6·7	19	6·4
Portsmouth	4	1·6	13	3·1	11	2·5
Salford	47	11·	63	11·	34	8·
Sunderland...	85	21·	25	6·2	15	3·8
Birmingham	—	—	45	7·	16	4·8
Bristol	—	—	17	7·1	15	3·3
Cardiff	—	—	16	5·6	30	4·3
Sheffield	—	—	80	12	23	5·6
Glasgow	—	—	—	—	35	6·2
London	—	—	—	—	25	4·7
Liverpool	—	—	—	—	35	7·

In comparing one town with another, further important information in establishing the relation between mortality and fatality will be found. The following Table Q shows that towns with a high average scarlet fever mortality have also a high average fatality; whereas towns with a low mortality have also a low fatality. I have added to this table a column showing the rate of mortality from all causes, which will be referred to subsequently.

TABLE Q.

Scarlet Fever Mortality and Fatality.			Mortality from all causes per 1,000 Population.	Scarlet Fever Mortality and Fatality.			Mortality from all causes per 1,000 Population.
	1884-93.				1884-93.		
	Mortality per 100,000 Population.	Fatality per 100 Cases.			Mortality per 100,000 Population.	Fatality per 100 Cases.	
Salford	57	10·0	24·9	Nottingham ...	17	4·3	20·4
Manchester ...	43	11·2	26·2	Leicester ...	11	4·2	20·3
Oldham	33	7·7	23·7	Portsmouth ...	11	2·5	18·6
Bradford	31	7·6	20·5				
Sunderland ...	31	5·8	22·3	Edinburgh ...	31	4·7	22·4
Birkenhead ...	30	5·9	20·2	Dundee	18	3·8	18·7
Newcastle-on-Tyne	28	4·5	22·0	Aberdeen ...	16	3·7	15·7

It is necessary to keep in mind that we are here dealing with fatality at all ages, which is liable to vary with age incidence. I find, however, that the age incidence of scarlet fever does not differ much in one town from another, or in one year from another in the same locality. Still it is probable that in the above comparison of fatality rates at all ages, the proportion of cases under five years of age does vary in the different towns, but not to such an extent as to invalidate the comparison. It would, however, add to the value of morbidity statistics if they were classified according to age, as has been done in some recent health reports, such as Manchester, London, and Leicester, from which the following figures have been prepared. I also add those for Mid-Lanarkshire, which has the lowest fatality rate, yet the largest proportion of cases under five years of age.

SHOWING PERCENTAGE FATALITY RATES AT THREE AGE PERIODS.

Age Periods.	Manchester, 1891-95.		London, 1893-94.		Leicester, 1893-94.		Mid-Lanarkshire, 1892-95.	
	Cases.	Fatality Rate.	Cases.	Fatality Rate.	Cases.	Fatality Rate.	Cases.	Fatality Rate.
0— 5	3,372	13·5	16,429	10·0	823	7·0	1,549	5·3
5—10	3,751	4·4	21,610	2·9	1,547	2·2	1,466	1·7
10 and over	2,249	2·0	17,302	1·6	932	2·0	922	0·9
All ages	9,372	7·1	55,341	4·5	3,302	3·3	3,937	2·9

Note the relatively smaller proportion of cases under five years of age in Leicester.

So far we have been considering the average fatality for a period of years, and have found a close relation between that and the average mortality; but it is even possible to trace this relation in the annual fluctuations of the disease.

To illustrate this and the relative influence of the two factors, morbidity and fatality in the production of mortality, I have prepared the following Diagram VII.

This shows that in Edinburgh and Copenhagen, the curve of fatality, even more than the curve of morbidity, follows closely the curve of mortality.

SUMMARY OF RESULTS.—From records of *morbidity*, we have learned (1) that a marked fall in scarlet fever mortality may occur without apparent diminution in morbidity or prevalence of the disease. (2) That scarlet fever is still a very prevalent disease in England and Scotland, attacking annually, on an average, about fifty persons in every 10,000 of the population. (3.) That in those towns where compulsory notification has been longest in operation, although the whole period is too short to make reliable comparisons between one part of it and another, we have to admit that no marked decline in the prevalence of the disease is perceptible, and that in several of those towns the average mortality has fallen without any corresponding fall in the morbidity.

From records of *fatality* we find (1) that in the Fever Hospitals of London and Glasgow, the

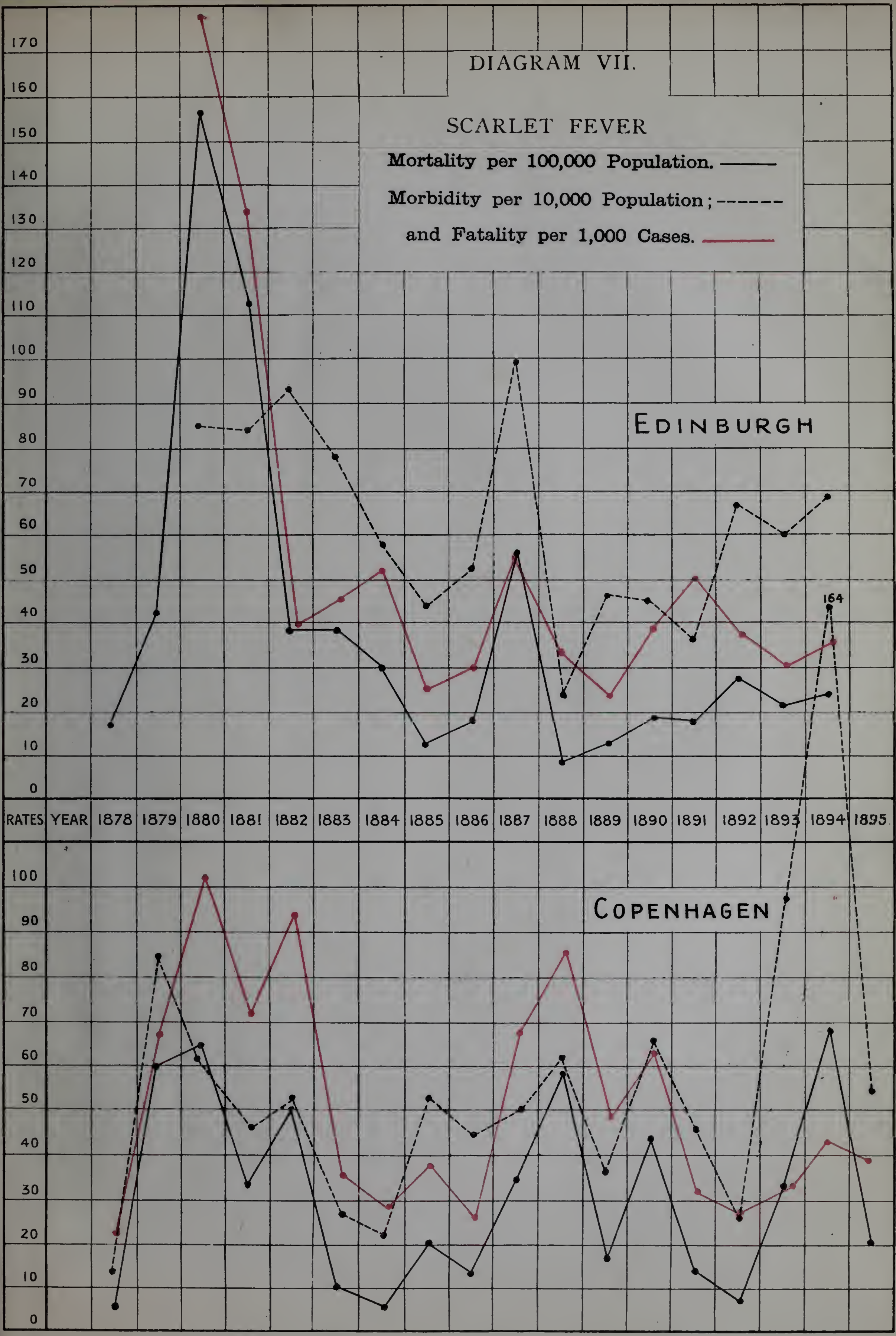

DIAGRAM VII.

SCARLET FEVER

fatality from scarlet fever has greatly declined. In the latter city there is a steady fall in each quinquennium, from 20 in 1866-70, to 6·3 in 1891-94 per 100 cases treated. (2.) When we compare the hospital fatality of one period with that of another, the reduction in fatality may, to the extent of sixty-five per cent., account for the reduction in mortality. (3.) That the progress of the general fatality in notification towns is similar to the progress of mortality. (4.) That when we contrast the average fatality of one town with another, we find that it corresponds with the mortality —towns with a high average fatality having also a high average mortality. (5.) That annual fluctuations of mortality are closely associated with similar fluctuations in fatality.

These results all point to the conclusion that fatality has been a much more powerful factor than morbidity in producing variations in the average mortality from scarlet fever.

While the foregoing statistics of morbidity and fatality are not sufficiently extensive, as regards time and area, to answer directly the question at issue—whether the diminution in scarlet fever mortality in Great Britain is due to diminished prevalence, diminished fatality or both—they indicate that the diminution in London and Glasgow, the two most populous cities, is chiefly due to a decline in the fatality of the disease.

Since the progress of mortality throughout Great Britain is similar to that in the above two largest cities, and since a diminution in the average mortality appears always to be associated with a diminution in the average fatality, we may almost conclude that a general decline in fatality has occurred throughout Great Britain, to which the general decline in mortality is largely due.

This question of diminished fatality we will pursue further, but first briefly note some statistics of morbidity and fatality in other countries.

MORBIDITY AND FATALITY IN OTHER COUNTRIES.—National registration of sickness is a praiseworthy feature of State administration in Scandinavia. Statistics of Scarlet Fever morbidity in Christiania have been obtained for the last thirty-five years, and are, with those for Stockholm and Copenhagen, shown in the following table, along with mortality and fatality rates :—

	CHRISTIANIA.			STOCKHOLM.			COPENHAGEN.		
Period.	Morbidity per 10,000 population.	Mortality per 100,000 population.	Fatality per 100 Cases.	Morbidity per 10,000 population.	Mortality per 100,000 population.	Fatality per 100 Cases.	Morbidity per 10,000 population.	Mortality per 100,000 population.	Fatality per 100 Cases.
1861-65	21	63	17·5	...	...	...	...	...	...
1866-70	66	111	19·3	*41	120	28·8	...	...	...
1871-75	38	52	10·4	28	57	22·6	...	...	...
1876-80	43	90	18·6	45	110	24·8	†53	43	6·3
1881-85	78	65	7·7	48	51	11·2	40	24	5·3
1886-90	75	71	9·6	43	74	16·9	51	33	5·8
1891-95	34	25	7·9	44	62	13·2	78	30	3·4
	Average	rates for	the last	fifteen	years	compared	with	previous	years.
1871-80	40·5	71	14·5	36·5	83	23·7	53	43	6·3
1881-95	62	54	8	45	62	13·8	56	29	4·8

* Year 1870. † Period 1878-80.

I have no means of determining whether these statistics of morbidity are strictly comparable with those of Great Britain obtained by means of notification fees, but by their study we obtain similar results.

The progress of scarlet fever mortality in Christiania and Stockholm has been very different from that in Great Britain. In the two Scandinavian towns there has been a comparatively slight decrease in the average mortality, and this has been due, not to a diminished prevalence, but to a diminished fatality, which seems to have set in with the period 1881-85. In the latter part of the above table the average rates for the years since 1881 are compared with those of previous years, showing that while fatality rates have decreased, morbidity rates have increased.

In Copenhagen also the diminished mortality is due to diminished fatality. Observe also that the mortality is highest where the fatality is highest. The average rates in Stockholm, Christiania, and Copenhagen for the last fifteen years were respectively :—Mortality 62, 54, 29; and fatality 13, 8, 4 (omitting decimals).

In the United States three-fourths of the population in the State of Massachusetts are now under compulsory notification. The fatality rates for the past five years in notification towns were 3·3, 4·6, 8·8, 6·8, and 5·9, giving an average of 6·1 for the period 1891-95. The average mortality rate was about 30, and the annual fluctuations were in the same direction as fatality.

FATALITY FURTHER CONSIDERED.

Change in Type of the Disease.—The one outstanding feature in the recent history of scarlet fever is the gradual diminution in its average fatality over a very wide area. Variations in fatality are generally associated with changes in the type of disease, and it would appear to be quite in accordance with the past history of scarlet fever if the reduced fatality, which we have observed during the last fifteen years, were essentially due to a diminished virulence in the average type of the disease. Thus, in places as widely apart as New York and Dublin, a thirty years' period of low fatality and benign type was experienced about the beginning of this century, and then the disease suddenly assumed a malignant form. A writer in Boston also observes, in 1819: "For more than thirty years past the scarlet fever has not appeared under a severe form in this place." * Of the progress of scarlet fever in Christiania we have a continuous record from 1825. In this year there was a widespread epidemic, which, "although often very violent, the illness was seldom fatal." The next extensive epidemic in 1835 was also mild, and it is not until the years 1841-2 that we read of the cases being complicated with "bad brain and throat affections." †

Sydenham, who describes scarlet fever from his experience in London (1661-75), speaks of it as "fatal only through the officiousness of the doctor," and does not mention any ulceration of the throat. In 1748 Fothergill described as a new and separate disorder, and Cullen as cynanche maligna, what was afterwards identified as scarlatina anginosa (Watson).‡ Willan states in his reports on the diseases in London (1801), "The Scarlet Fever with an ulcerated sore throat had prevailed every autumn from the year 1785 to 1794, and proved extremely fatal. This complaint began to decline in 1795, and is at present only sporadic." The relative prevalence of this type of scarlet fever in Great Britain during the early part of this century cannot be ascertained.

The recent experience of this country and the United States of America, as expressed in the reports of health officers, is that scarlet fever has for some years been of a benign type. The graver forms of the disease are still met with, but they do not prevail. Comparatively few cases occur with marked angina, a feature of the disease which in former times made it difficult to distinguish it from diphtheria. Difficulties of diagnosis at the present day are mainly concerned with the recognition of the mildest cases, and differentiating them from non-specific ailments.

Still, the average type varies enormously in different communities. For instance, the Borough of Salford Fever Hospital reports for the years 1894 and 1895 show that over 40 per cent. of the cases treated were of the anginous type, and about 10 per cent. of the malignant type. The yearly fatality rates were 10·2 and 7·9 per cent., and were similar to those in the town generally. Now, in Lanarkshire, during the same period, the fatality rates were under 4 per cent., and hospital experience there, though limited, showed that the proportion of cases treated which could possibly be classed as of an anginous type did not exceed 4 per cent., and that the malignant cases did not exceed 1 per cent.

Classification of cases according to type is an arbitrary method, and in order to determine the relation of fatality to type it would be better to compare the actual clinical phenomena observed in the cases for a series of years in different localities.

Clinical statistics, showing to what extent the frequency and severity of the more important symptoms and complications have varied with fatality are, considering the number of fever hospitals in the country, extremely scarce. Observations, such as those made by Gresswell in 1887-88,§ show to what an extent the clinical symptoms vary in the course of an epidemic; but continuous observations, extending over long periods in rate-supported hospitals, are not published, except by the Metropolitan Asylums Board. These publications show that during the last eight years the occurrence of albuminuria has become less frequent. During the five years 1888-92 albuminuria was observed in 13 per cent. of the total cases treated; while, during the three years 1893-95, the average frequency was only 7·6 per cent.

Owing to the paucity of recorded observations, it is impossible to compare the changes that have occurred in the clinical phenomena with the decline in fatality. Nor is it possible, owing to want of uniformity in observation and tabulation, to compare the hospital statistics of one town with another. Clinical observations would be very helpful in seeking to account for the reduction in fatality during past years, and for the differences in fatality which still prevail in different com-

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* "Historical Pathology."—*Hirsch.*

† "Beretning om Folkemaengden og Sundhedstilstanden," i. Christiania, i. Aaret (1892).

‡ "Principles and Practice of Physic," iii. Ed., II. Vol., p. 813 (1848).

§ "Natural History of Scarlatina" (1890).

munities. Uniform clinical statistics might constitute a basis from which other observations would spring, and even prove helpful in working out the bacteriology of scarlet fever.

Variations in fatality are probably largely concerned with influences affecting the life history of an obligatory parasite which is the actual cause of the disease. But it is possible that in the severer types involving the cervical glands and cellular tissue, these complications are due to a mixed infection. Hospital experience combined with the investigations of the sanitary departments might show that the influences which promote variations in type and fatality are well within the range of practical hygiene.

It is believed that the change to a benign type not only manifests itself by a low fatality, but also by a diminished power of diffusion. The direct outcome of which should be to diminish the prevalence of the disease; but this may not necessarily be the ultimate result, since along with diminished power of diffusion, there also exists difficulty of recognition, and thus increased facilities for diffusion, even in the presence of the best possible organized system of prevention. In the absence of such facilities, a decrease in fatality is likely to be accompanied by diminished prevalence or decrease in morbidity.

We will now consider scarlet fever in relation to sanitary administration.

The Influence of Preventive Measures.—These measures comprise: (1) the education of the public as to their duty in the early recognition, notification, and isolation of cases occurring in persons under their care; (2) control of school attendance; (3) regulation of milk supplies; (4) compulsory notification; (5) hospital isolation; and (6) Disinfection at the expense, and by the order of sanitary authorities and their officers.

That these are all excellent and highly approved prophylactic measures will not be disputed, and it is now incumbent upon sanitary authorities and the general public throughout Great Britain to see that they are carried out.

But this condition of things is of very recent date. Active preventive measures against scarlet fever, during the two decades 1870-90 were confined almost entirely to the large towns. Since 1890 they have gradually become general. The decline in mortality began in the Seventies (and coincides with the commencement of preventive efforts), but we have seen that the decline in mortality was not confined to the large towns which led the way in active prevention; towns without even the nucleus of a sanitary department, and rural districts which made no pretence to sanitary effort of any kind, all participated in the reduction of scarlet fever mortality. Again, in comparing one country with another, we find in some, which have not even yet practised hospital isolation (*e.g.* United States), the mortality has fallen just as in those which have hospital isolation. On general grounds we may safely assert that preventive measures, especially hospital isolation, where exercised, must have had some influence in lowering mortality. By isolation, dissemination of infection is checked, and prevalence of the disease diminished. By proper hospital treatment fatality is lessened, and there is evidence in the reports of health officers that these benefits have in some measure been attained.

Without attempting to estimate the prophylactic effects of such measures in the reduction of mortality in localities where they have been in force, we may, in considering the cause of the general reduction which has occurred throughout Great Britain, almost leave them out of account, as the country in general did not enjoy the benefit of such measures to any great extent during the period under consideration.

As in the days of Graves, at the beginning of the century, when many physicians in Dublin attributed the reduced fatality of scarlet fever, as compared with previous years, to their method of treatment, so at the present day it is not uncommon to find reasons, expressed or implied, for the reduction in scarlet fever mortality, quite at variance with those which the result of my enquiry seems to indicate. Diminished mortality has been largely attributed to hospital isolation*, and the percentage (70 to 80 in some towns) of scarlet fever cases removed to hospital is frequently held up as a criterion in sanitary administration.

It is to be feared that the prophylactic value of this excellent sanitary measure is, by some authorities, over-rated. If we contrast the progress of mortality in some of the principal towns in Scotland with the preventive measures in force, we find that in Glasgow, hospital isolation was largely practised without notification; in Dundee, notification was in force, but almost no hospital isolation; in Edinburgh both measures were in operation, while in Leith neither were to any extent in operation. Yet the reduction in scarlet fever mortality was slightly greater in Leith and Dundee than in Edinburgh or Glasgow. Or again, take Aberdeen, where the reduction in scarlet fever mortality occurred early, and where, during the past ten years, all modern preventive measures have been in full operation—notification, hospital isolation, etc.,—and yet no diminution in prevalence has occurred during these years. In Denmark the experience of Copenhagen, and in England the experience of such places as Nottingham, are instructive in the same direction.

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* In the final report of the Royal Commission on Vaccination, the Commissioners say:—"We think that the steps which have been taken, in various ways, to isolate persons suffering from scarlet fever have largely contributed to this decline," while the dissenters tell us, without hesitation, that regarding smallpox, scarlet and typhus fevers in London, "the recent development of proper hospital isolation has been most strikingly effectual in reducing, almost to insignificance, the mortality from those diseases, in the case of which it has been most largely resorted to."

When we take a wide survey of the movement of scarlet fever mortality, as I have endeavoured to do, it becomes apparent that some more widely operating influence must have been at work in bringing about the reduction that has taken place.

THE INFLUENCE OF GENERAL SANITARY MEASURES.—It seems to be generally accepted that scarlet fever in its causation and dissemination is little influenced by general sanitary measures, and probably this is so. But there are some facts which point to a close relation between fatality and sanitation; thus it is not uncommon to find the worst forms of the disease associated with overcrowded, dirty, or damp dwellings. Again, if we compare the average scarlet fever fatality rates with the general mortality rates (*i.e.*, mortality from all causes) in British towns, as given in Table Q, we find that scarlet fever fatality varies directly with general mortality. A high fatality is associated with a high general mortality, a low fatality with a low general mortality. These facts demand fuller inquiry than it is possible for me at present to undertake, but they seem to point to a close relation between fatality and general sanitation.

It would also appear that scarlet fever fatality is higher in large towns than in rural districts, in which there is also a similar difference in general mortality. In Glasgow the average fatality rate was 6·2 for the years 1891-94, whereas in Lanarkshire (non-burghal) the fatality rate was 3·3 per cent. for the whole county, and only 2·2 in the more rural portions of it. The Scottish Local Government Board separate the notification returns received from County and Burgh authorities. The districts under the county, though mainly rural in character, contain many small towns, yet the Board's classification affords, to a certain extent, a means of comparing for the whole of Scotland, urban and rural fatality. The rate in burgh districts during 1893-95 was 4·1 per cent., as compared with 2·9 in the non-burghal districts.

It may be questioned whether the difference in these rates is due to a lower fatality at all ages, or simply to a difference in the age incidence of the disease. The Lanarkshire age-statistics suggest the former alternative. Material for a comparison of urban and rural fatality in England is not available. Hart's compilation of the 1892 returns shows that in those counties with a large urban population the fatality rate was generally much higher than in those counties with a large rural population—*e.g.*, fatality per cent. in Lancaster was 7·2, in West Riding 5·2, in Surrey 1·9, and in Sussex 1·2. This comparison of urban and rural districts tends to show that scarlet fever is less fatal in the country than in the town.

From these considerations it seems reasonable to conclude that conditions which tend to promote general health have also a controlling influence over the fatality of scarlet fever. Unhealthy conditions may act in two ways. By lowering the vitality, children are rendered less able to survive an illness of any kind, but in scarlet fever unhealthy conditions may also indirectly, through the human subject, propagate a more virulent contagion. We have seen that the progress of scarlet fever mortality in Great Britain has been similar to that of certain other diseases, which have undoubtedly been influenced by sanitary progress (Diagram VI.). To what extent sanitation has influenced scarlet fever mortality it is, at present, not possible to determine.

Other influences may also have been at work. MacDowall* points to the average mean temperature in England (Greenwich), which has shown a long, steady rise from 40·5° in 1838, to 43·5° in 1850; then after some fluctuations at the high level, returns to 40·6° in 1887; and observes, "One is disposed to ask whether the long wane of temperature may not have something to do with the course of scarlet fever." To such questions there seems no answer possible, until those influences we have considered are more fully investigated. And this cannot be accomplished without the united efforts of health officers and hospital superintendents, acting under the guidance of a well-equipped, liberally-staffed central authority, such as our Local Government Boards ought to be.

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* "Weather and Disease," 1895.